

1 Kevin G. Donohoe as ~~inventors~~, and which is now U.S. Patent No. —  
2 \_\_\_\_\_, the disclosure of which is incorporated by reference.

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4 At page 7, line 23 before "conducted" insert --is--.

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6 **In the Claims:**

7 Cancel claims 8, 9, 14, 15, 29, 43, 51 and 52 without prejudice.

8  
9 Pending Claims 1-7, 10-13, 16-28, 30-42, 44-50 and 53-57 are  
10 presented hereinbelow for the Examiner's benefit.

11  
12 1. A plasma etching method comprising:  
13 forming a polymer comprising carbon and a halogen over at least  
14 some internal surfaces of a plasma etch chamber; and  
15 after forming the polymer, plasma etching using a gas effective to  
16 etch polymer from chamber internal surfaces; the gas having a hydrogen  
17 component effective to form a gaseous hydrogen halide from halogen  
18 liberated from the polymer.

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20 2. The plasma etching method of claim 1 wherein the halogen  
21 is selected from the group consisting of fluorine, chlorine and mixtures  
22 thereof.  
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2 3. The plasma etching method of claim 1 wherein the halogen  
comprises fluorine.

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4 4. The plasma etching method of claim 1 wherein the gas also  
5 comprises an oxygen component.

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7 5. The plasma etching method of claim 1 wherein the gas also  
8 comprises O<sub>2</sub>.

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10 6. The plasma etching method of claim 1 wherein the hydrogen  
11 component comprises NH<sub>3</sub>.

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13 7. The plasma etching method of claim 1 wherein the hydrogen  
14 component comprises H<sub>2</sub>.

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16 10. A plasma etching method comprising:  
17 forming a polymer comprising carbon and a halogen over at least  
18 some internal surfaces of a plasma etch chamber; and  
19 after forming the polymer, plasma etching using a gas effective to  
20 etch polymer from chamber internal surfaces; the gas comprising a  
21 carbon compound effective to getter the halogen from the etched  
22 polymer.  
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1 11. The plasma etching method of claim 10 wherein the gettering  
2 comprises forming a gaseous hydrogen halide from the etched halogen.

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4 12. The plasma etching method of claim 10 wherein the gettering  
5 comprises forming a gaseous  $\text{COA}_x$  compound, where A is the etched  
6 halogen.

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8 13. The plasma etching method of claim 10 wherein the carbon  
9 compound comprises a hydrocarbon.

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11 16. The plasma etching method of claim 10 wherein the carbon  
12 compound comprises a C-O bond.

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14 17. The plasma etching method of claim 10 wherein the carbon  
15 compound comprises CO.

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17 18. The plasma etching method of claim 10 wherein the carbon  
18 compound comprises CO formed from  $\text{CO}_2$  injected into the chamber.

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20 19. The plasma etching method of claim 10 wherein the halogen  
21 comprises fluorine.

1 20. The plasma etching method of claim 10 wherein the gas also  
2 comprises an oxygen component.

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4 21. A plasma etching method comprising:  
5 positioning a semiconductor wafer on a wafer receiver within a  
6 plasma etch chamber;

7 first plasma etching material on the semiconductor wafer with a  
8 gas comprising carbon and a halogen, a polymer comprising carbon and  
9 the halogen forming over at least some internal surfaces of the plasma  
10 etch chamber during the first plasma etching; and

11 after the first plasma etching and with the wafer on the wafer  
12 receiver, second plasma etching using a gas effective to etch polymer  
13 from chamber internal surfaces and getter halogen liberated from the  
14 polymer to restrict further etching of the material on the semiconductor  
15 wafer during the second plasma etching.

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17 22. The plasma etching method of claim 21 wherein the receiver  
18 is biased during the first plasma etching and provided at ground or  
19 floating potential during the second plasma etching.

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21 23. The plasma etching method of claim 21 wherein the gas  
22 comprises hydrogen which combines with the halogen during the second  
23 plasma etching to form a gaseous hydrogen halide.

1 24. The plasma etching method of claim 21 wherein the second  
2 etching is conducted with a temperature of the receiver provided at from  
3 about -10°C to about 40°C and at a chamber pressure of from about 30  
4 mTorr to about 5 Torr.

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6 25. The plasma etching method of claim 21 wherein the halogen  
7 comprises fluorine.

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9 26. The plasma etching method of claim 21 wherein the gas  
10 comprises an oxygen component.

11  
12 27. The plasma etching method of claim 21 wherein the gas  
13 comprises  $\text{NH}_3$ , with hydrogen from the  $\text{NH}_3$  combining with the halogen  
14 during the second plasma etching to form a gaseous hydrogen halide.

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16 28. The plasma etching method of claim 21 wherein the gas  
17 comprises  $\text{H}_2$  which combines with the halogen during the second plasma  
18 etching to form a gaseous hydrogen halide.  
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30. The plasma etching method of claim 21 wherein the first and second plasma etchings are conducted at subatmospheric pressure, and the wafer remaining *in situ* on the receiver intermediate the first and second etchings, and maintaining the chamber at a subatmospheric pressure at all time intermediate the first and second plasma etchings.

31. The plasma etching method of claim 21 wherein the gettering comprises forming a gaseous COA<sub>x</sub> compound, where A is the etched halogen.

32. The plasma etching method of claim 21 wherein the gas comprises a carbon compound effective for the gettering.

33. The plasma etching method of claim 32 wherein the carbon compound comprises a hydrocarbon.

34. The plasma etching method of claim 32 wherein the carbon compound comprises a C-O bond.

35. The plasma etching method of claim 32 wherein the carbon compound comprises CO.

36. A plasma etching method comprising:

positioning a semiconductor wafer on a wafer receiver within a plasma etch chamber, the semiconductor wafer having a photoresist layer formed thereon;

first plasma etching material on the semiconductor wafer through openings formed in the photoresist layer with a gas comprising carbon and a halogen, a polymer comprising carbon and the halogen forming over at least some internal surfaces of the plasma etch chamber during the first plasma etching; and

after the first plasma etching and with the wafer on the wafer receiver, second plasma etching using a gas having one or more components effective to etch photoresist from the substrate and polymer from chamber internal surfaces and getter halogen liberated from the polymer to restrict further etching of the material on the semiconductor wafer during the second plasma etching.

37. The plasma etching method of claim 36 one of the gas components comprises hydrogen which combines with the halogen during the second plasma etching to form a gaseous hydrogen halide.

38. The plasma etching method of claim 36 wherein one of the gas components comprises  $O_2$  and another is hydrogen atom containing.

1 39. The plasma etching method of claim 36 wherein one of the  
2 gas components comprises  $O_2$  and another is hydrogen atom containing,  
3 said one component and said another component being provided in the  
4 chamber during the second plasma etching at a volumetric ratio of the  
5 one to the another of at least 0.1:1.

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7 40. The plasma etching method of claim 36 wherein the halogen  
8 comprises fluorine.

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10 41. The plasma etching method of claim 36 wherein one of the  
11 gas components comprises  $NH_3$ , with hydrogen from the  $NH_3$  combining  
12 with the halogen during the second plasma etching to form a gaseous  
13 hydrogen halide.

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15 42. The plasma etching method of claim 36 wherein one of the  
16 gas components comprises  $H_2$  which combines with the halogen during  
17 the second plasma etching to form a gaseous hydrogen halide.

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19 44. The plasma etching method of claim 36 wherein the first and  
20 second plasma etchings are conducted at subatmospheric pressure, and  
21 the wafer remaining *in situ* on the receiver intermediate the first and  
22 second etchings, and maintaining the chamber at a subatmospheric  
23 pressure at all time intermediate the first and second plasma etchings.

1 45. The plasma etching method of claim 36 wherein the gettering  
2 comprises forming a gaseous  $\text{COA}_x$  compound, where A is the etched  
3 halogen.

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5 46. The plasma etching method of claim 36 wherein the gas  
6 comprises a carbon compound effective for the gettering.  
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1 47. A plasma etching method comprising:

2 positioning a semiconductor wafer on an electrostatic chuck within  
3 an inductively coupled plasma etch chamber, the semiconductor wafer  
4 having a photoresist layer formed on an insulative oxide layer, the  
5 photoresist layer having contact opening patterns formed therethrough;

6 first plasma etching contact openings within the insulative oxide on  
7 the semiconductor wafer through the contact opening patterns formed in  
8 the photoresist layer with a gas comprising carbon and fluorine, a  
9 polymer comprising carbon and fluorine forming over at least some  
10 internal surfaces of the plasma etch chamber during the first plasma  
11 etching; and

12 after the first plasma etching and with the wafer on the  
13 electrostatic chuck, providing the electrostatic chuck at ground or floating  
14 potential while second plasma etching using a gas comprising an oxygen  
15 component and a hydrogen component effective to etch photoresist from  
16 the substrate and polymer from chamber internal surfaces, and forming  
17 HF during the second plasma etching from fluorine liberated from the  
18 polymer to restrict widening of the contact openings formed in the  
19 insulative oxide resulting from further etching of the material on the  
20 semiconductor wafer during the second plasma etching.

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22 48. The plasma etching method of claim 47 wherein the oxygen  
23 comprises O<sub>2</sub>.

1 49. The plasma etching method of claim 47 wherein the hydrogen  
2 component comprises  $\text{NH}_3$ .

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4 50. The plasma etching method of claim 47 wherein the hydrogen  
5 component comprises  $\text{H}_2$ .

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7 53. The plasma etching method of claim 47 wherein the first and  
8 second plasma etchings are conducted at subatmospheric pressure, and  
9 the wafer remaining *in situ* on the electrostatic chuck intermediate the  
10 first and second etchings, and maintaining the chamber at a  
11 subatmospheric pressure at all time intermediate the first and second  
12 plasma etchings.  
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54. A plasma etching method comprising:

positioning a semiconductor wafer on an electrostatic chuck within an inductively coupled plasma etch chamber, the semiconductor wafer having a photoresist layer formed on an insulative oxide layer, the photoresist layer having contact opening patterns formed therethrough;

first plasma etching contact openings within the insulative oxide on the semiconductor wafer through the contact opening patterns formed in the photoresist layer with a gas comprising carbon and fluorine, a polymer comprising carbon and fluorine forming over at least some internal surfaces of the plasma etch chamber during the first plasma etching; and

after the first plasma etching and with the wafer on the electrostatic chuck, providing the electrostatic chuck at ground or floating potential while second plasma etching using a gas comprising an oxygen component and a carbon component effective to etch photoresist from the substrate and polymer from chamber internal surfaces, and gettering fluorine liberated from the polymer during the second plasma etching with the carbon component to restrict widening of the contact openings formed in the insulative oxide resulting from further etching of the material on the semiconductor wafer during the second plasma etching.

55. The plasma etching method of claim 54 wherein the gettering comprises forming a gaseous hydrogen halide from the etched halogen.

1 56. The plasma etching method of claim 54 wherein the gettering  
2 comprises forming a gaseous  $\text{COA}_x$  compound, where A is the etched  
3 halogen.

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5 57. The plasma etching method of claim 54 wherein the carbon  
6 compound comprises a C-O bond.  
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